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(54) **Electrical signal mixing apparatus**

(57) Electrical signal mixing apparatus for recording studios or for live performances comprises a plurality of input channels (12) having means (96, 97, 98, 99) for conditioning input signals applied thereto, a plurality of sub-group channels (10) to which the signals from input channels (12) can be selectively assigned, and a pair of output channels (17) which may receive signals directly from the input channels (12) or via the sub-group channels (10). Routing interconnections between the input (12), sub-group (10) and output (17) channels are controlled by a microprocessor in dependence on operator selections effected via a single manually operable switch control (15, 18) on each channel. The microprocessor detects destination assignments indicated by operation of the switch (18) on a sub-group (10) or output (17) channel, and acts to complete analogue interconnections between input channels (12) and the identified sub-group (10) or output (17) channels upon subsequent actuation of the input channel selector switches (15). The microprocessor control of routing assignments also allows other functions to be performed, such as storage and retrieval of sets of routing assignments or patches used previously or set up for subsequent use, indication of current routing assignments, muting of selected channels to allow in place solo review of individual input channel signals and the additional possibility of handshake with an external computer for obtaining a video display of the information.

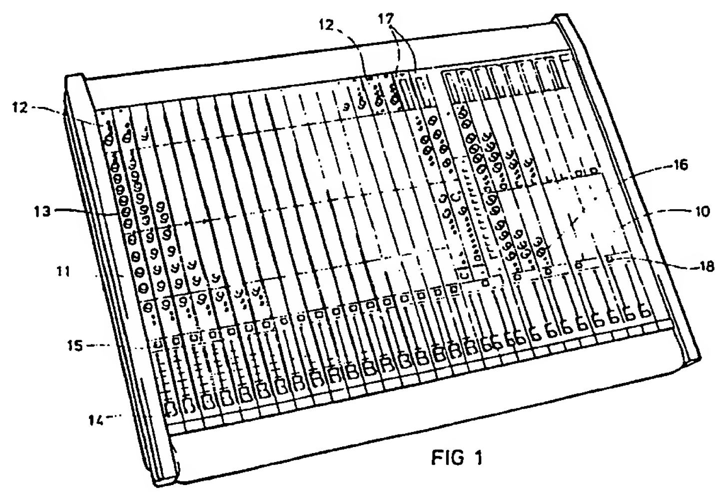

FIG 1

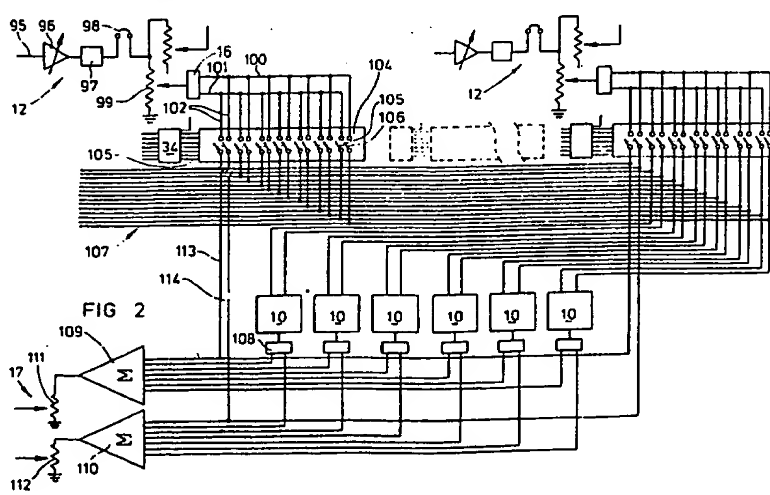

FIG 2

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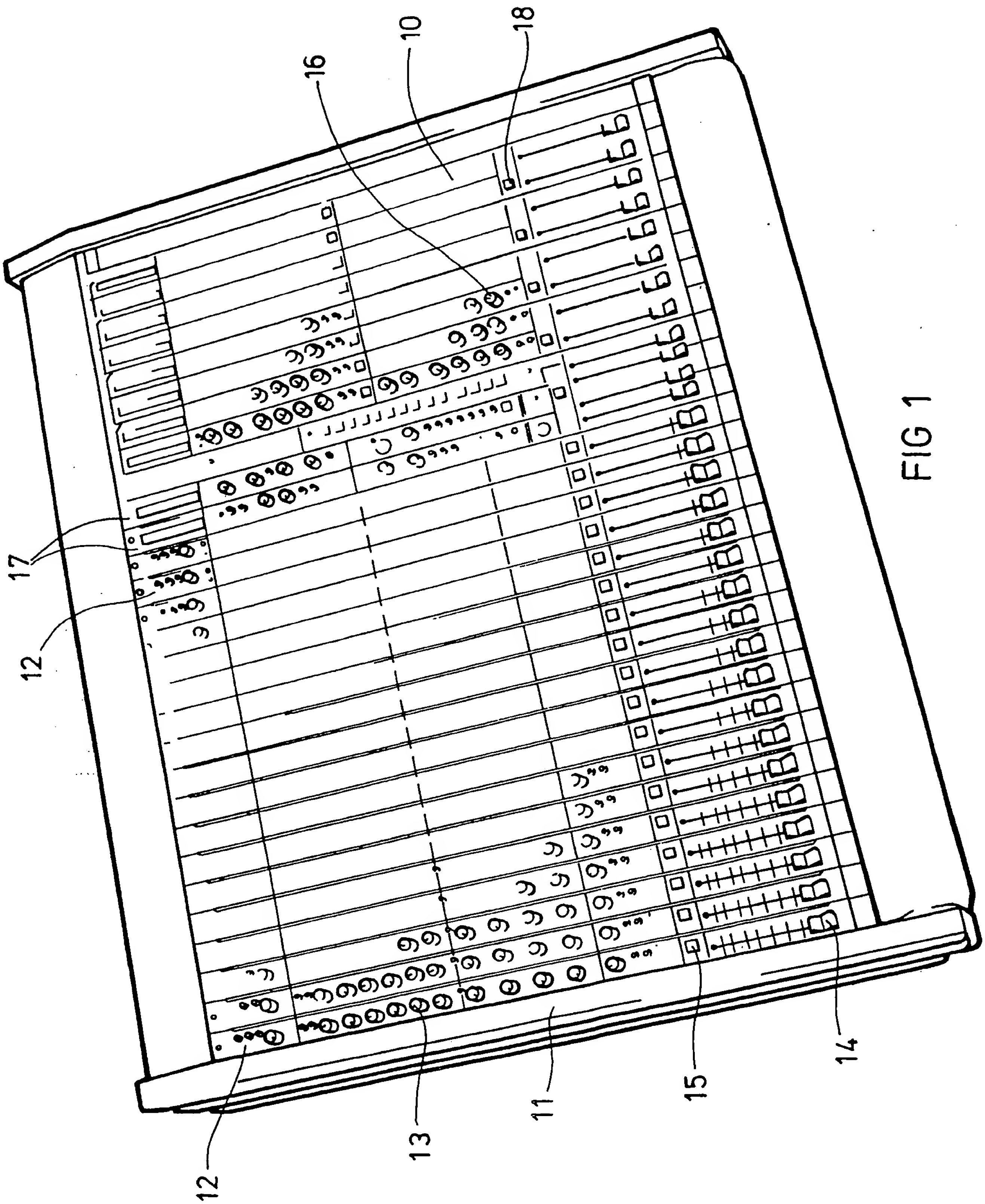

FIG 1

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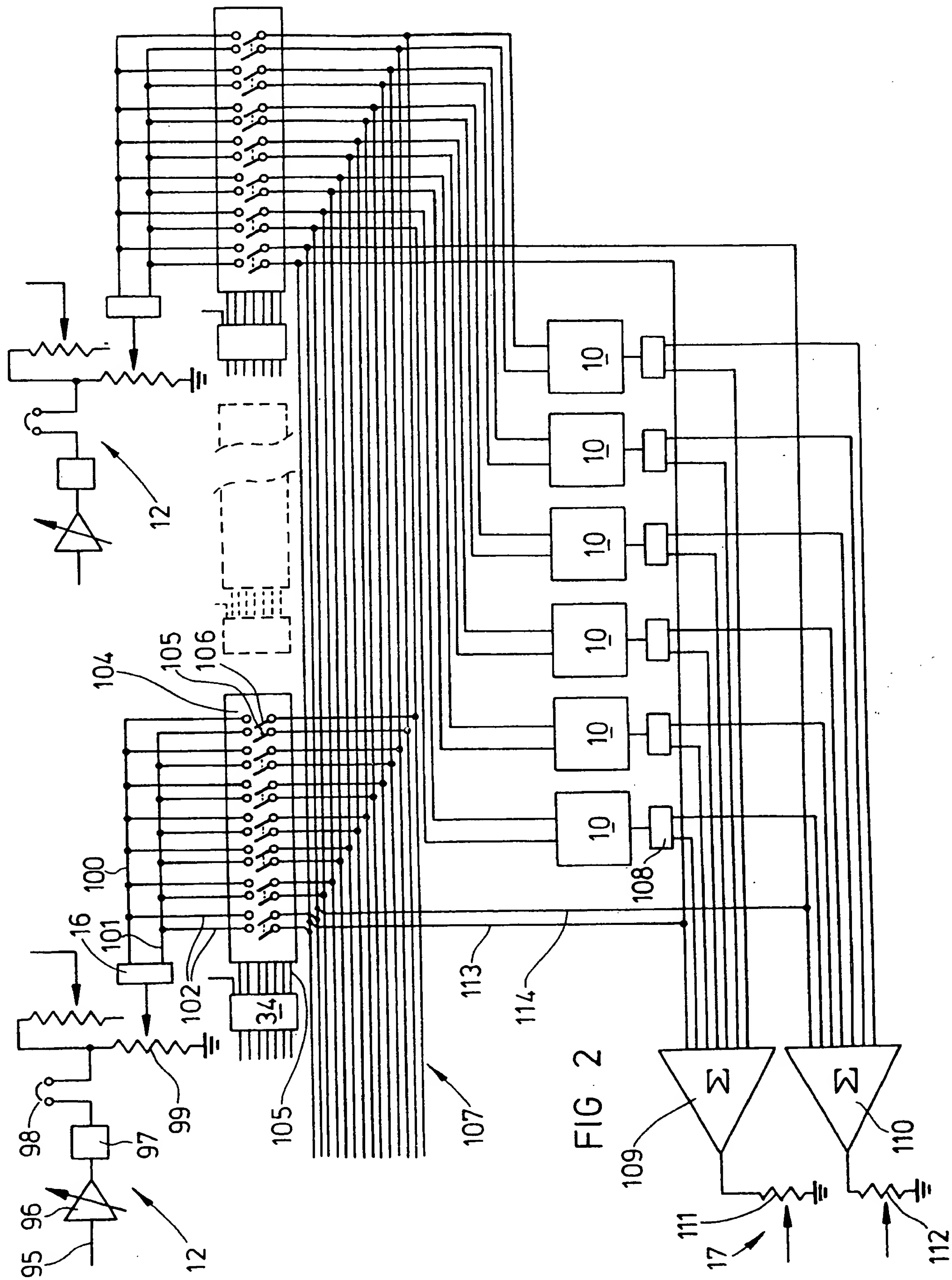

FIG 2

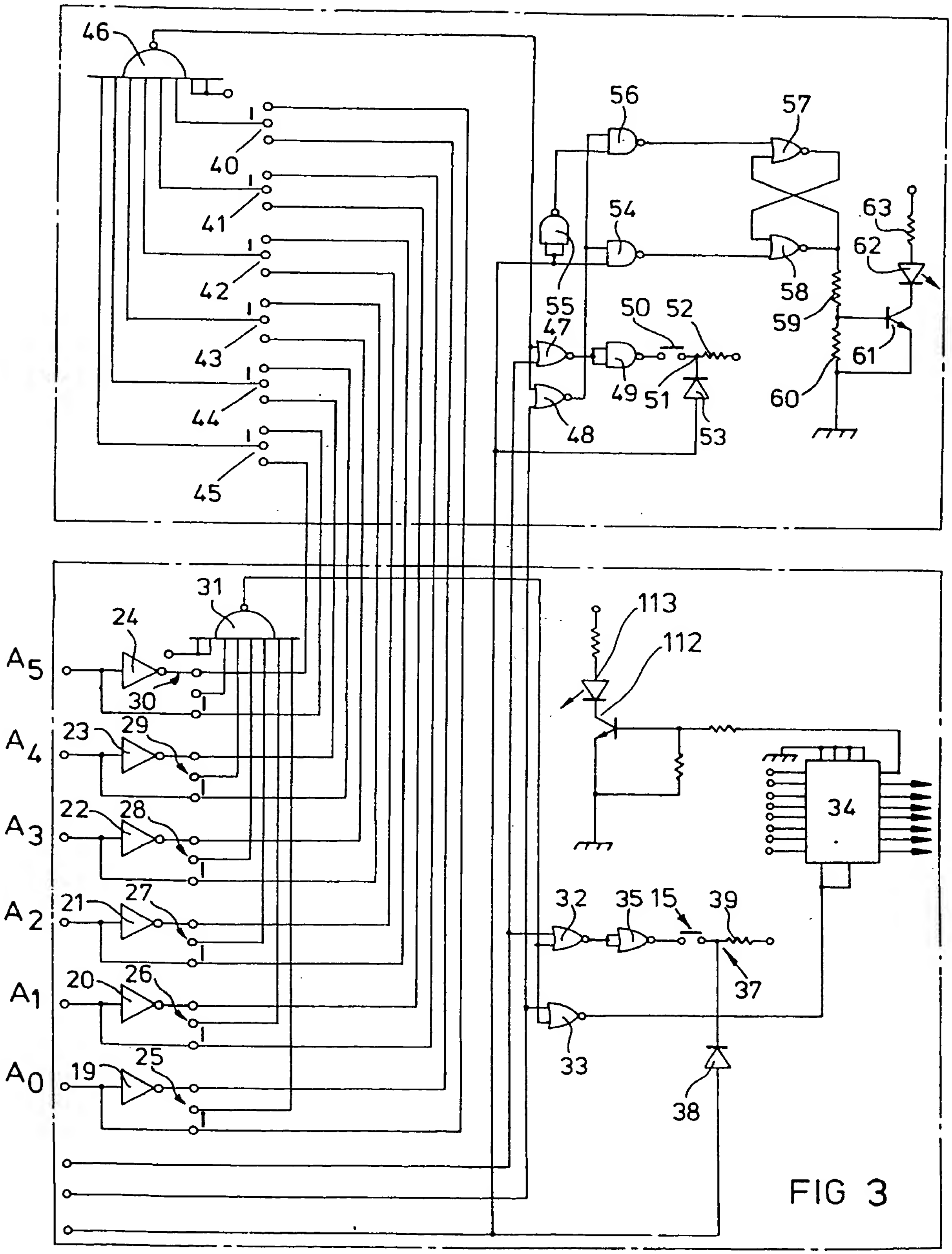
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FIG 3

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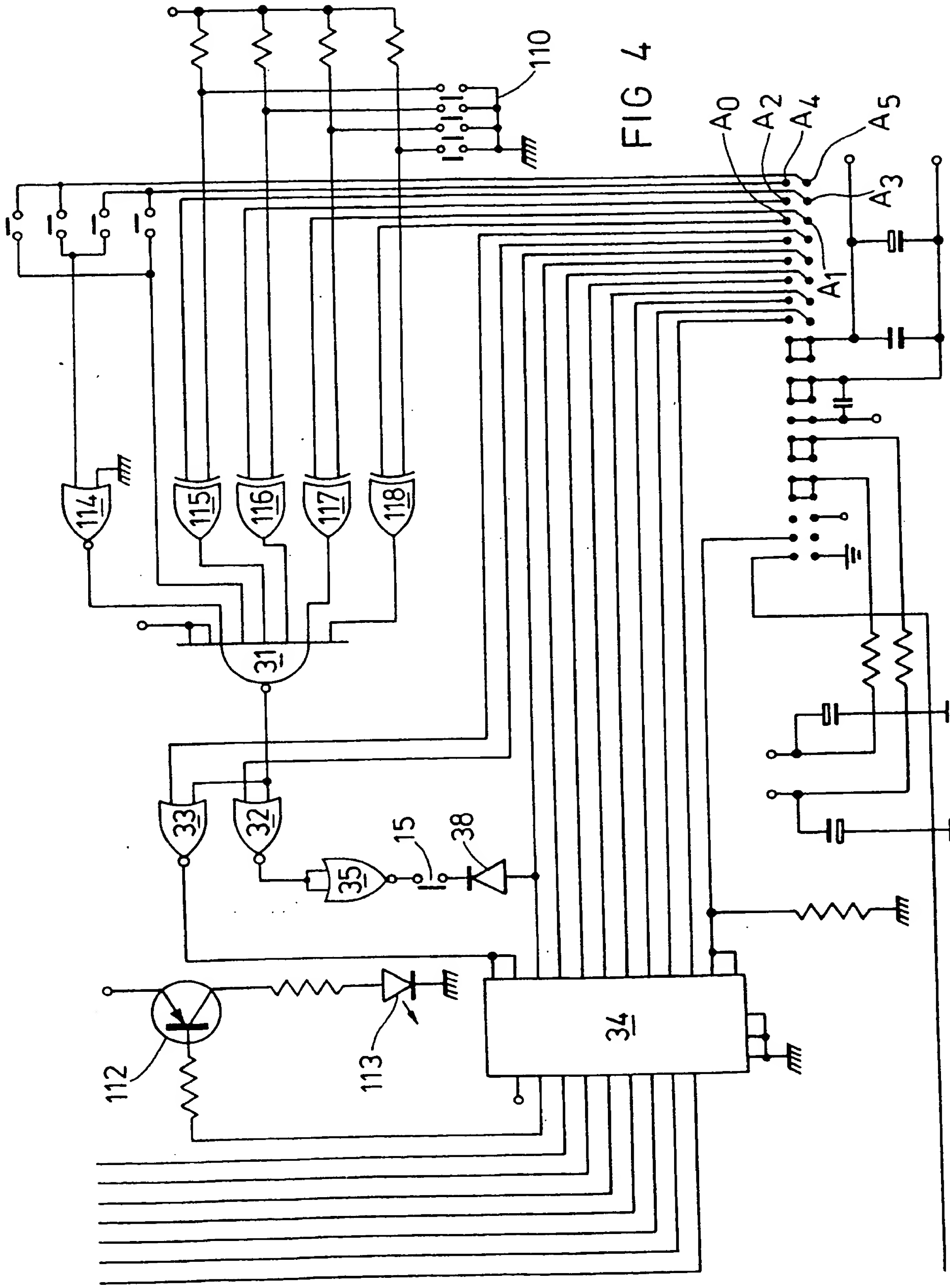

FIG 4

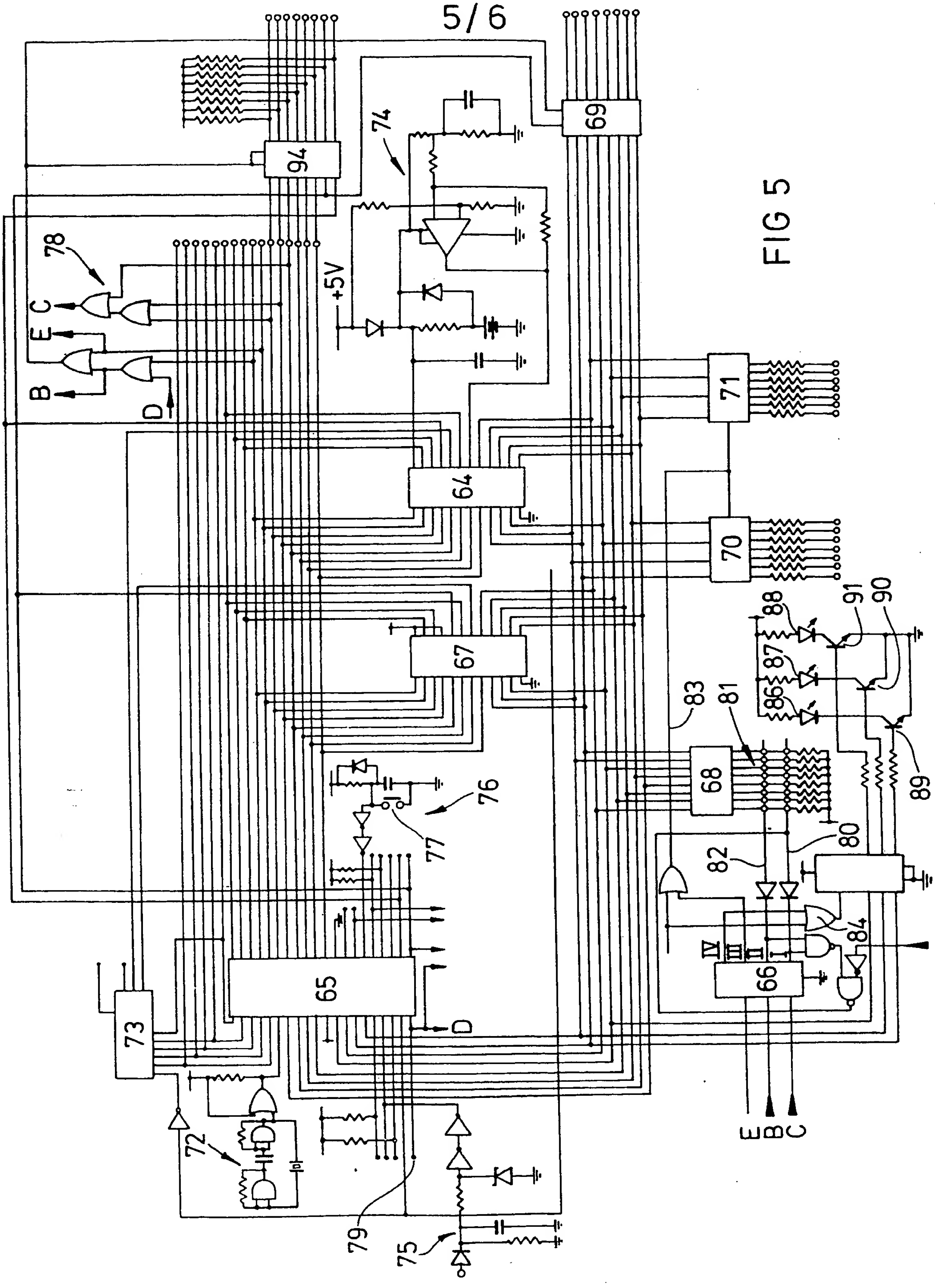
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FIG 5

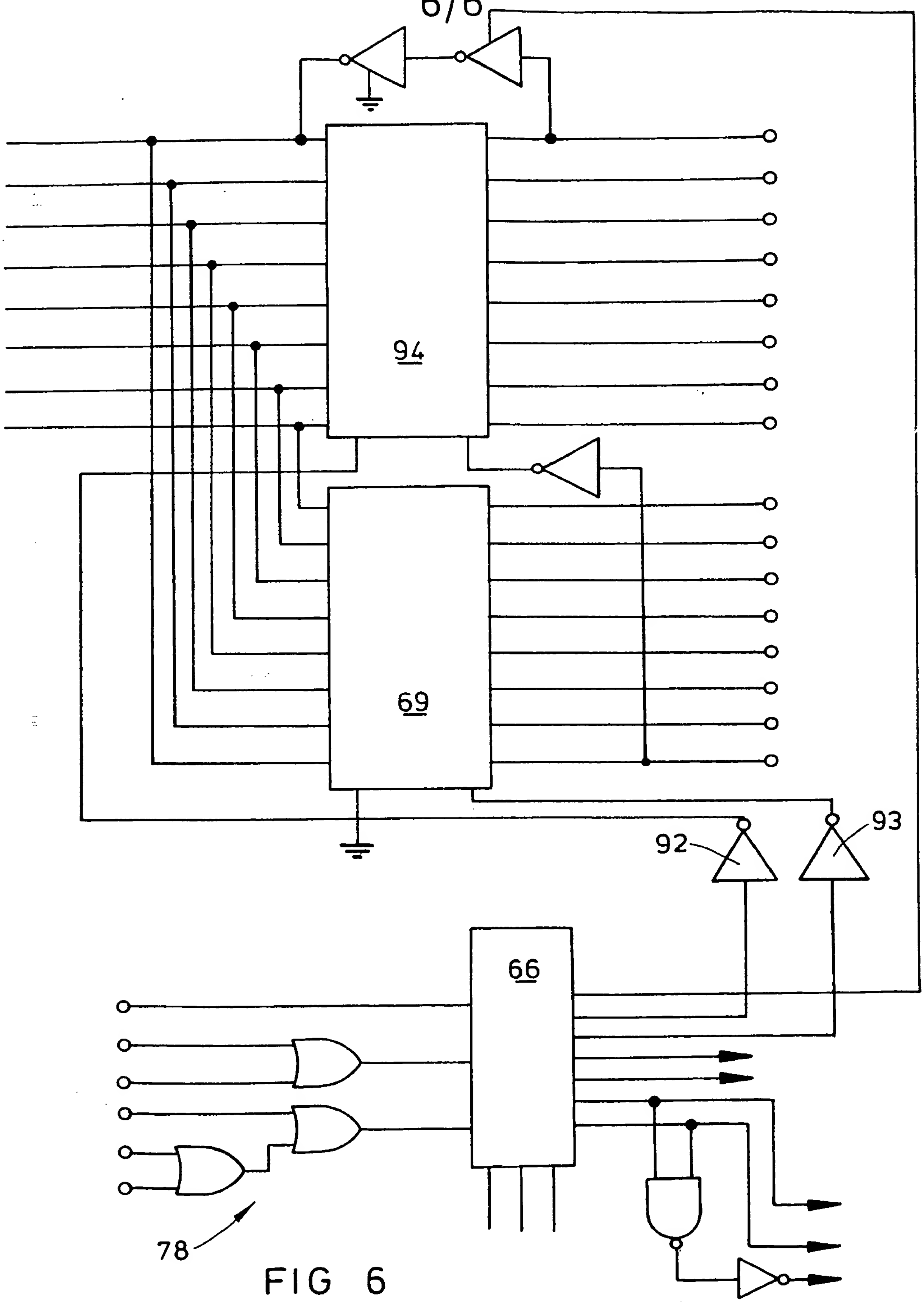

FIG 6

replaced with blank modular units to vary the number of units in the mixer. This is possible because of the microprocessor control which allows each channel to be routed by means of only a single channel routing control switch so that no change in the routing controls is required if the mixer is modified at any time.

The processor preferably further operates to provide channel connection display of the interconnections made when in its normal working mode (as opposed to the "setting up" mode during which the channel interconnections are selected) by providing illumination of suitable illuminable means identifying the interconnected channels. For this purpose a lock/unlock control is provided to enable channel selection when in its unlocked state and to inhibit channel selection when locked. In operation of the mixer, when the lock/unlock control is locked and a sub-group channel selector is operated this causes the illumination of the channel indicator means indicating each of the input channels connected thereto. Likewise, operation of the input channel selector in the same circumstances will cause illumination of an indicator on the sub-group channel or channels to which it is connected.

Provision is made for a video monitor to be incorporated with the device for displaying information concerning the patches in the memory. In particular the mixer is provided with a connection port known in the art as an RS232 port for connecting the mixer to an external computer having a V.D.U. In this way information may be displayed, or alternatively any one of a number of stored patches may be called up to the monitor screen for display. The system also allows changes to be made to a stored patch without corrupting a current patch which may be in use at the time.

Various embodiments of the present invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an external view of a mixing device formed as an embodiment of the present invention;

Figure 2 is a schematic circuit diagram illustrating the analogue interconnection of input channels, sub-group channels and output channels;

Figure 3 is a schematic circuit diagram illustrating part of the digital control of the analogue connections;

Figure 4 is a schematic circuit diagram illustrating an alternative form of digital control;

Figure 5 is a circuit diagram illustrating the general arrangement of the microprocessor control components of an embodiment of the present invention; and

Figure 6 is a partial diagram illustrating a modification of the embodiment of Figure 5.

Referring first to Figure 1, the electrical signal mixer shown comprises a generally rectangular casing 11 with a plurality of modular channels extending from top to bottom. These channels are of three types, namely input channels 12, of which there are eighteen in the embodiment of Figure 1, sub-group channels 10, of which there are eight arranged in four stereo pairs, and two output channels 17. The input channels 12 each has a connector (not shown) for connection with a line leading from a respective signal source, which may be a microphone or other transducer. The input channels 12 have a plurality of control knobs 13 for varying the parameters and characteristics of the input signal, and a volume control or "fader" slide 14 by means of which the relative volume of each input channel can be controlled. Further, each input channel 12 has a routing control switch 15 which is used for making selective interconnections between that input channel and any of the sub-group channels 10 or either of the output channels 17. The sub-group channels do not extend to the top of the mixer casing 11 and the upper region is occupied by a set of auxiliary returns which are known in the art and do not form an inventive feature of the mixer of the present invention.

The sub-group channels 10 have channel routing control switches controlled by push-buttons 18 and are grouped in pairs with a single control switch 18 determining connections of the two channels of a pair to selected input channels. Each sub-group channel pair has a "pair" control which directs a proportion of the signal on a channel to each of the left/right channel parts and the outputs from the sub-group channels are fed to the left or right output channel in proportion determined by the "pan" control which is in the form of a rotary control knob 16.

As will be described in greater detail below, interconnections between the input channels 12 and the sub-group channels 10 are determined by depression of the route selector push-buttons 18 and 15. The analogue connections made in this way will now be described with reference to Figure 2, which illustrates two input channels 12 and the interconnections to the two output channels 17 and sub-group channels 10. Only two input channels 12 are illustrated in Figure 2, and the ghost outline represents the remaining input channels of which, as in the embodiment of Figure 1, there may be eighteen, although in other embodiments a greater number of channels up to thirty-six may be provided. Each input channel has an input line 95 leading to an amplifier 96, an equalisation circuit 97 and an "inject" socket 98, all of which are standard components for audio mixers and will not be described in greater detail here. Other signal modifying circuits may be provided, but as with the circuit components described, these are conventional in the art and do not affect the routing system of the present invention, merely having been illustrated for completeness.

The channel 12 also has a variable resistor 99 which is connected to the slide control 14 to serve as the main volume control or "fade" for that channel. The output from this fade is fed to a pan control 16 operating to direct the signal from

the fader 99 onto two respective lines 100, 101 which represent the left and right stereo parts of the signal. Adjustment of the pan control 16 will vary the proportion of the signal fed into the lines 100, 101 from an extreme left hand end position where one hundred per cent of the signal is fed to line 101 and zero to line 100 and an extreme right hand position where the inverse relationship occurs. Each of the lines 100, 101 is connected by seven pairs of lines 102 to seven contact pairs 103 of a set of electronic switches, represented in the diagram as mechanical switches but which will be understood hereinafter to be any conventional electronic means. The whole switching system for the channel 12 may be mounted on a single switch card and in Figure 2 this has been identified by the reference numeral 104. By applying decoded signals to the appropriate input line 105 to the switch card 104 an appropriate switch is closed to complete the circuit from one or other of the lines 100, 101 to the output side of the card. The switches of the switch card 104 are individually connected to respective lines of a main analogue signal bus 107 the lines of which lead into sub-group channels 10 in respective pairs. The sub-group channels 10 have been illustrated as boxes, but may include conventional signal modifying components such as those illustrated in the input lines 12, or others for conditioning the signal to provide special audio effects, such as "echo" and the like. The outputs from the sub-group channels 10 are fed by respective pan controls 108 to respective summing amplifiers 109, 110 the outputs of which feed variable resistors 111, 112 constituting the main output fade controls of the output channels.

Apart from the interconnections to these sub-group channels 10, each switch card 104 also has a pair of connections leading directly to one of the amplifiers 109, 110 and the left hand input channel 12 of Figure 2 is shown connected by lines 113, 114. Thus, by suitably closing the switches on the switch card 104 the output lines 100, 101 may be connected either to one of the other summing amplifiers 109, 110 of the output channels, or to a selected sub-group channel control of the switches is effected by a decoder latch 34 which receives digital information on its input lines and decodes this to control the analogue switches on the card 104. The analogue switches are linked so that the seven outputs on the line 105 from the decoder 34 controls pairs of switches in the array, the first and third switch being connected together for simultaneous operation, and likewise the second and fourth, etc.

The manner in which the digital control signal to be applied to the latch 34 is generated will now be described in relation to Figure 3.

As will be seen in Figure 3, address information is applied to six microprocessor address lines labelled A_0, A_1, A_2, A_3, A_4 and A_5. These are connected to inverters 19—24 each of which feeds one pole of a respective double pole switch from the set indicated 25—30. The other pole of the switches 25—30 is connected to the respective address line up-stream of the respective inverter 19—24.

The middle pole of each of the double pole switches 25—30 is connected to a NAND gate 31 the output from which leads to the inputs of two NOR gates 32, 33. The other input of the NOR gate 32 is connected to the "read" line of the microprocessor, and the other input of the NOR gate 33 is connected to the "write" line. The output of the NOR gate 33 is connected to the enable input of the decoder/latch 34 each output from which controls a left/right pair of audio switches from the bank of analogue switches 104.

The output of the NOR gate 32 is connected to both inputs of a NOR gate 35 the output of which leads to a routing switch 15 connected at a circuit node 37, to the cathode of a diode 38, and to the positive supply via a resistor 39. The anode of the diode 38 is connected to the INT line of the microprocessor.

The components described thus far constitute the route selecting part of one input channel of the mixer. The other seventeen input channels are also connected by similar sets of six double pole switches identical to the switches 25—30 to the address lines A_0—A_5, although the setting of the switches between the inverted and non-inverted lines will be different whereby uniquely to identify each input channel. The microprocessor operates to apply all the different addresses sequentially onto the address lines. The upper part of Figure 3 illustrate the route selection components of a sub-group channel, which like the input channel has a set of six double pole switches 40—45 for uniquely identifying that channel. Although only one output channel is illustrated in Figure 2, it will be appreciated that all of the sub-group channels will similarly be connected to the address lines A_0—A_5. The central poles of the switches 40—45 are connected to inputs of a NAND gate 46 the output of which supplies two inputs of two NOR gates 47, 48. The second input of the NOR gate 47 is connected to the "read" line and the second input of the NOR gate 48 is connected to the "write" line. The output of the NOR gate 47 is connected to both inputs of a NAND gate 49 the output of which leads to a sub-group routing switch 18 connected in a configuration similar to that of the routing switch 15 in the input channel, that is to a node 51 connected to the positive supply via a resistor 52 and to the cathode of a diode 53 the anode of which is connected to the INT line of the microprocessor.

The output of the NOR gate 48, on the other hand, is connected to one input of a NAND gate 54 the other input of which is connected to the INT line and the output of which is connected to one input of a NOR gate 58 connected in latching configuration with a NOR gate 57 the second input of which is fed from a NAND gate 56 which receives input signals from the NOR gate 48 and from a NAND gate 55 both inputs of which latter

are connected to the INT line. The output of the latching pair of NOR gates 57, 58 is fed via two biasing resistors 59, 60 to digital ground. To the junction between the two biasing resistors 59, 60 is connected the base of a transistor 61 the collector-emitter junction of which is connected in series with a light-emitting diode 62 supplied from the positive digital supply via a resistor 63. The emitter of the transistor 61 is grounded at digital ground.

In operation the address lines are supplied cyclically with sequential addresses and when the address matches that set by the channel selecting switches 25—30 or 40—45 the output of the associated NAND gate such as the gate 46 changes state. When the output of the NAND gate 46 in the sub-group or master channel changes state this enables the two NOR gates 47 and 48 which receive signals also on the read and write lines. The depression of the push-button 50 is sensed on the INT line in coincidence with the address gated through the NOR gate 47 and the NAND gate 49 and triggers a processor sub-routine to interrogate all the input channel switches as a scan on the read line to determine which of these channel selection switches have been depressed, and to generate, on the data bus, signals representing the address of the sub-group or master channel at which a push-button has been depressed.

As with the sub-group or master channel, when the address on the address bus matches that set on the switches 25—30 to identify that channel the NAND gate 31 changes state and its output, gated with the read and write lines in NOR gates 32, 33, enables these gates to transmit the read and write signals when they are generated; thus when the read or write lines go low, the output from the NOR gates 32 or 33 go high respectively. When the output from the NOR gate 32 goes high, that is as the read line goes low, the output from the NOR gate 35 goes low which forward biases the diode 38 if the route selecting switch 36 is depressed, effectively applying a signal to the INT line. When the "write" line subsequently goes low the NOR gate 33 applies an enable signal to the decoder/latch 34 the outputs of which each control a pair of analogue switches as described in detail above in relation to Figure 2 to directly connect the input channel to the selected sub-group or output channel.

Figure 4 illustrates an improved input channel routing control circuit in which the expensive double pole switches have been replaced by dual-in-line switches 110 one terminal of each of which is earthed and the other of which is connected via a resistor 111 to the supply voltage.

In Figure 4 those components which are the same or fulfil the same function as corresponding components in the embodiment of Figure 3 will be identified with the same reference numerals. Thus, the latch 34 is fed with data information and controlled via a NOR gate 33 enabled by the microprocessor write line and switched by the NAND gate 31 when the appropriate address appears on the address A0—A5, the NAND gate being gated by a system of exclusive OR gates 114—118 the inputs to which are, respectively, the terminals of the dual-in-line switch 110 which are connected to the power supply and the address lines themselves. In this embodiment, as in the embodiment of Figure 3, depression of the switch 15 causes the decoder 34 to decode the data on the data lines when the appropriate address appears on the address lines whereby to energise the analogue switches with the decoded output from the decoder 34.

The general arrangement of the microprocessor circuit is illustrated in Figure 5 where the Random Access Memory is shown by the reference numeral 64 connected to a Z80 microprocessor 65 the clock input of which is fed by an oscillator generally indicated 72. A decoder 73 scans the line and writes on to the data bus for transfer and comparison with a look-up table in an EPROM 67. The information stored in the RAM 64 represents the inter-connections selected for each of a plurality of patches and, of course, it is important that this information should remain in the memory even if the mixer is switched off, or in the event of power failure. For this reason a battery-powered back-up system, generally indicated 74, is provided to maintain power to the RAM 64 when the mains power is removed for any reason. If the power fails an AC detector generally indicated 75 detects the level and triggers when a certain threshold is reached. This signal is fed to a non-maskable interrupt terminal of the Z80 focusing it into a shutdown routine which preserves the information so that if a power failure occurs the information will be securely retained. In conjunction with the AC detector 75 is a reset system 76 which acts as the threshold is passed on power-up to ensure that the processor starts the programme at the first address location as it commences operation. This ensures synchronisation between the data and address information. A reset button 77 is provided for occasional use should this be required.

The processor 65 has an input/output request pin 79 which, as shown by the arrow D is connected to one input of a gating system 78 the other inputs of which are taken from the address bus and which provide signals at selected address locations which are provided on output B, E and C linked, as shown by input arrows E, B and C respectively to the inputs of a decoder 66. Only at one code will the first of the output pins, identified with the reference numeral I, of the decoder 66 become active, so that the line connected thereto will go low. This line, identified as line 80, is connected to eight switches of a switch pad 81 having sixteen switches the other eight of which are connected to a line 82 and a second pin II of the decoder 66. The switch pad 81 is connected via a buffer 68 to the data bus. At a different address location the decoder 66 will cause the output pin II to go low thereby scanning the second row of switches on the pad 81. These

sixteen switches (only fourteen of which are used in the present embodiment) control the special functions of the system and act, for example, to lock or unlock the keyboard from operation on the microprocessor, to store the information, cancel the information, recall the information and so on.

At a further address location the output line III from the decoder 66 goes low. This is gated with the write line of the processor and fed on line 83 as an "enable" signal to decoder/latches 70, 71 which feed data from the data bus to two seven segment display devices (not shown) which identify the patch being operated on at any one time. The decoder latches act on four data lines and provide outputs on seven lines for the seven segment displays.

Further, the decoder 66 has a fourth output pin IV which is also gated with the write line of the processor at a gate 84 and acts to enable a latch 85 which controls three status- indicating light-emitting diodes 86, 87, 88 via three respective driver transistors 89, 90, 91 respectively. The first of these status-indicator LEDs namely the LED 86 indicates whether there is an error, the second indicator LED 87 indicates whether the keyboard is locked or unlocked so that it can be programmed, and the third status LED 88 indicates that the system is in the "interrogate" mode enabling the operator to investigate the connection made in other patches without affecting the current patch. These functions are controlled by the switches on the key pads 81, and the status LEDs 86, 87, 88 operate to indicate which of the associated switches has been pressed.

Referring now to Figure 6 the alternative embodiment illustrated is adapted for the Z80 processor to put all the data and address information on the address lines. The data bus buffer 69 is here shown connected to the address bus and the enable inputs fed via inverters 92, 93 required because the data bus buffer 69 in this embodiment and the corresponding address bus buffer 94 are of opposite logic from those in the embodiment of Figure 3.

The decoder 66 and its input logic 78 correspond to the equivalently identified components in the embodiment of Figure 5, but the decoder 66 now has further outputs connected to the inverters 92, 93 for directly enabling the buffers 69, 94.

In an alternative embodiment (not shown) the microprocessor is adapted to read the SMPTE synchronisation and timing code which is recorded on audio-recording tape in recording studios and the like. This, together with timing control circuits in the mixer enables a current patch to be changed for one stored in the RAM 64 at a predetermined time in a programme.

CLAIMS

1. Electrical signal mixing apparatus having a plurality of input channels for receiving input electrical signals to be processed, a plurality of output channels adapted for delivering processed electrical signals in selected combinations from the input channels, and means interconnecting the input channels and the output channels and operating to direct signals arriving on each input channel to one or more selected output channels, in which the interconnection means includes a microprocessor operating to generate a series of address signals representing address locations of the output channels; and routing assignment control means comprising first selector means on the output channels for identifying a selected output channel as a route destination, the microprocessor generating data signals representing the selected output channel in response to operation thereof, and second selector means on the input channels operable to connect one or more selected input channel as a route source to the selected route destination in response to the data signals applied thereto by the microprocessor.

2. Electrical signal mixing apparatus as claimed in Claim 1, further including a plurality of sub-group channels also assignable as route destinations for signals from the input channels, means interconnecting the sub-group channels and the output channels whereby to direct signals from the sub-group channels to selected output channels, and third selector means for identifying a selected sub-group channel as a route designation.

3. Electrical signal mixing apparatus as claimed in Claim 2, in which the first selector means on the output channels include a single manually operable switch and gating means connected to the said microprocessor such that upon actuation of the manually operable switch associated with a selected channel the microprocessor acts to generate a data signal on data lines thereof identifying the address of the selected output channel or sub-group channel, and means interconnecting the data lines with the second selector means.

4. Electrical signal mixing apparatus as claimed in Claim 3, in which the second selector means includes a decoder/latch circuit for each input channel, connected to the data lines of the microprocessor whereby to receive the signals representing the selected output channel or sub-group channel address locations, the second selector means for each input channel further including a single manually operable switch and gating means for enabling the decoder/latch upon operation of the manually operable switch in coincidence with address identifying signals applied to address lines of the microprocessor.

5. Electrical signal mixing apparatus as claimed in Claim 4, in which the decoder/latch output is connected to an analogue switch circuit comprising a plurality of analogue switches selectively operable under the control of the decoder/latch to apply signals from the input channel to selected interconnection lines of the apparatus to which the output channels and the sub-group channels are permanently connected.

6. Electrical signal mixing apparatus as claimed

in Claim 5, in which the microprocessor has an associated random access memory for storing signals representing the switching status of all the analogue switches of all the second switching means of the input channels whereby to store signals representing a whole set or patch of routing connections from all selected input channels to all selected sub-group channels and output channels.

7. Electrical signal mixing apparatus as claimed in Claim 6, further comprising a keyboard having switching means for identifying the memory locations in the random access memory at which signals representing routing connections are stored, whereby to select storage locations and to retrieve stored signals selectively.

8. Electrical signal mixing apparatus as claimed in Claim 7, further comprising selector enable means, the said keyboard including a lock/unlock key operation of which acts on the selector enable means whereby to enable or to disable the first, second or third selector means of each channel.

9. Electrical signal mixing apparatus as claimed in any of Claims 2 to 8, in which each sub-group output comprises a stereo pair of output lines from a variable pan control device operable to determine the proportion of the overall output signal assigned to each line of the pair, means connecting one line of each pair to a first output channel and means connecting the other line of each pair to a second output channel, the apportionment of the sub-group outputs to the said two output channels being effected entirely by adjustment of the pan control devices.

10. Electrical signal mixing apparatus as claimed in any of Claims 2 to 9, in which the sub-group channels further include means for conditioning the signals or group of signals arriving from the input channels prior to delivery to the output thereof.

11. Electrical signal mixing apparatus as claimed in any of Claims 2 to 10, in which each of the said first, second and third selector means have associated illuminable indicators for indicating the status of the said first, second and third selector means in determining the routing connections between the input channels, the sub-group channels and the output channels.

12. Electrical signal mixing apparatus as claimed in Claim 8, further comprising timer means operable to activate the selector enable means for a predetermined time after the last actuation of one of the said first, second and third selector means, and to disable further activation thereof after the said predetermined time if no further selector is operated during this time.

13. Electrical signal mixing apparatus, comprising a plurality of input channels for receiving input electrical signals, each input channel having means for conditioning a received input signal and channel routing selectors, a pair of output channels comprising left and right members of a master stereo pair, for receiving conditioned signals from the input channels in dependence on the actuation of respective channel routing selectors, a plurality of sub-group channels for receiving conditioned signals from selected input channels and incorporating further means for additionally conditioning sub-group signals in the sub-group channel, means interconnecting the sub-group channels and the master output channels, and microprocessor means controlling the selectable interconnection of one or more input channels to one or more of the sub-group channels or the output channels in dependence on the actuation of the channel routing selectors.

14. Electrical signal mixing apparatus as claimed in Claim 13, in which the microprocessor means include a memory having a plurality of sets of address locations for storing data identifying all the routing connections between the input channels, the sub-group channels and the output channels constituting one selection of such routing connections for a working patch of the mixing apparatus.

15. Electrical signal mixing apparatus as claimed in Claim 14, in which there are further provided means for selectively inhibiting all routing connections of a patch whereby to isolate in the mixing apparatus the routing connections from a selected single input channel to the master output channels either directly or through a sub-group channel.

16. Electrical signal mixing apparatus substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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H04H 7/00

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(58) Field of Search
UK CL (Edition N) **H4R RSX**
INT CL^6 **H04H 7/00**
Online : WPI, INSPEC

(54) Audio mixing console

(57) An audio mixing console 10 includes user controls which can be dynamically allocated by buttons 32 to respective processing channels enabling a compact audio mixing console to be provided with full functionality, but with only a relatively small number of user operable controls including allocatable channel faders 26 and allocatable audio signal processing control knobs 38 and buttons 39, etc. Individual control values for the user operable control can be updated, maintained and retained for each of the processing channels which can be allocated to the individual user operable controls. Also, a single processing channel can be allocated to a user operable control on two sub-panels 22, 24 of the control panel 12 and the user operable controls on both sub-panels can be used separately to control the processing within that channel. The resulting changes in the user operable control "positions" are displayed at 34, as a result of the dual control of a processing function within a processing channel by respective user operable controls on the respective sub-panels. Keys 28 select a particular group of channels (e.g. 24 from 128) for a particular sub-panel, 22, 24. Panel 40 controls centralised functions.

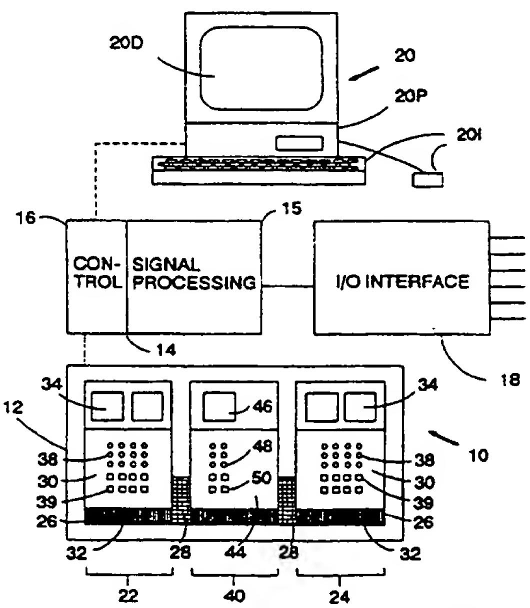

FIG. 1

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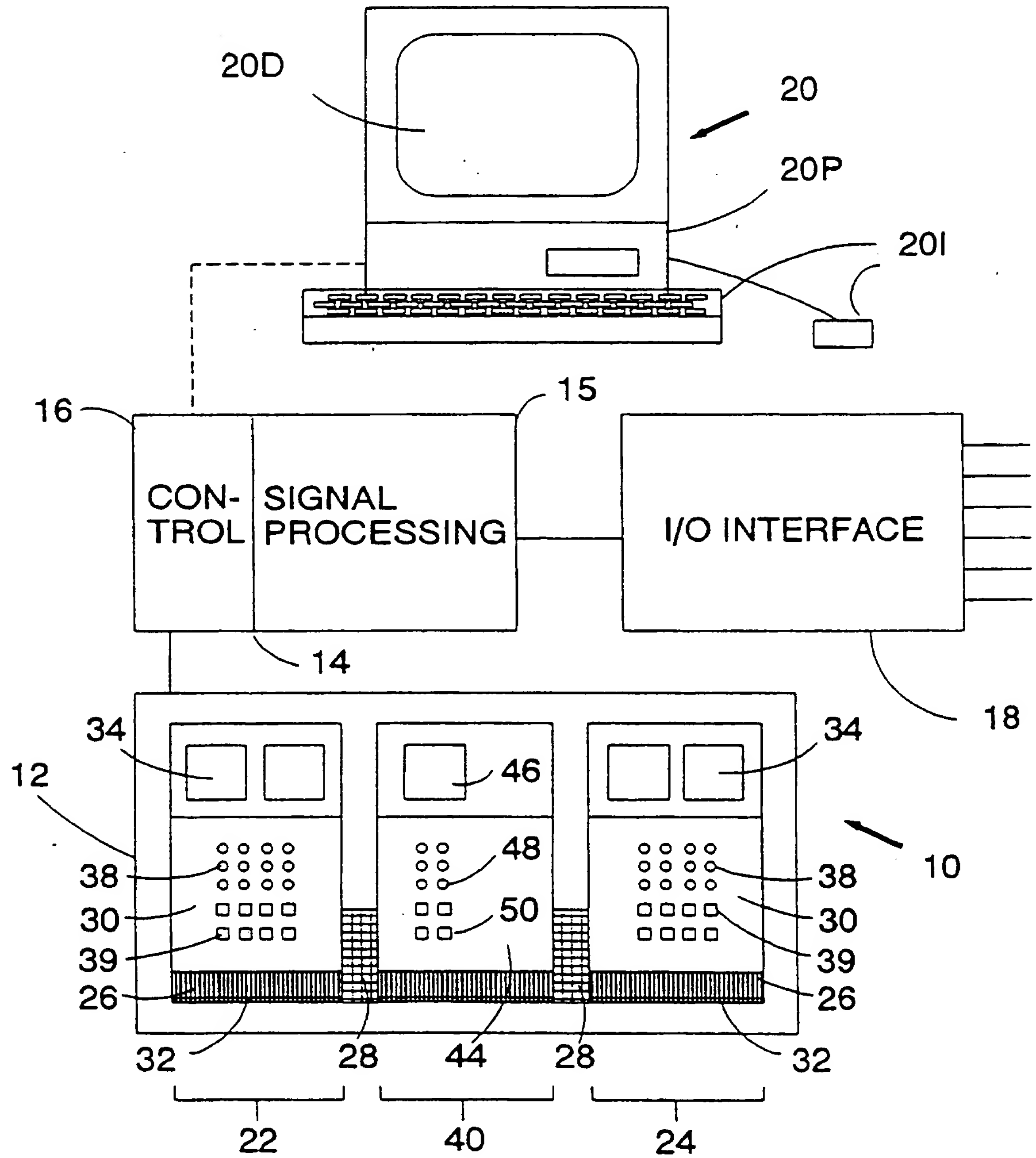
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18
34
46
34
12
48
10
38
38
30
50
30
39
39
26
26
32
28
44
28
32
22
40
24

FIG. 1

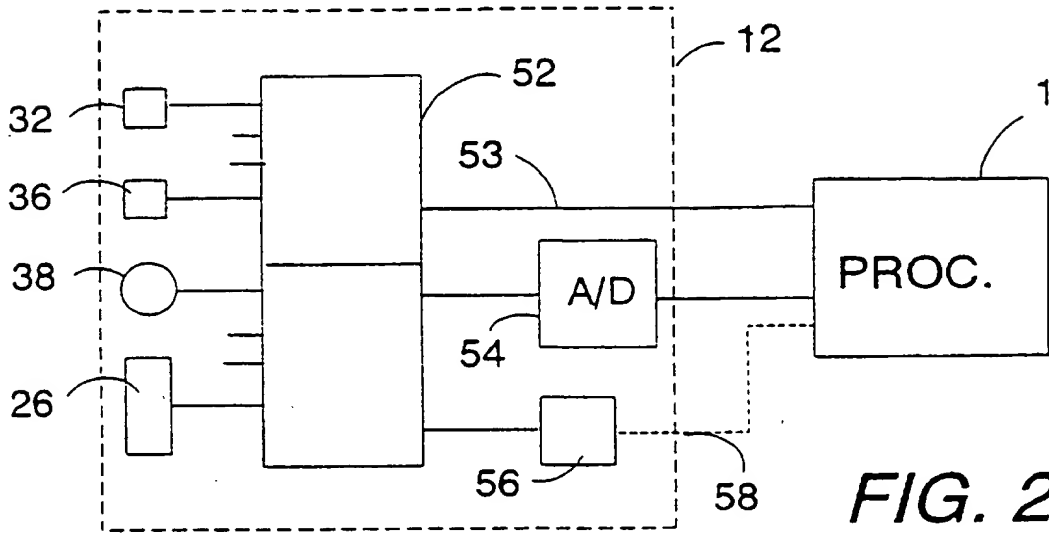


FIG. 2

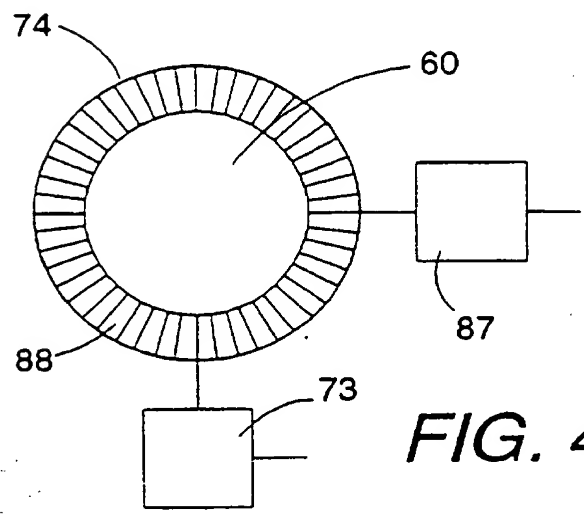


FIG. 4

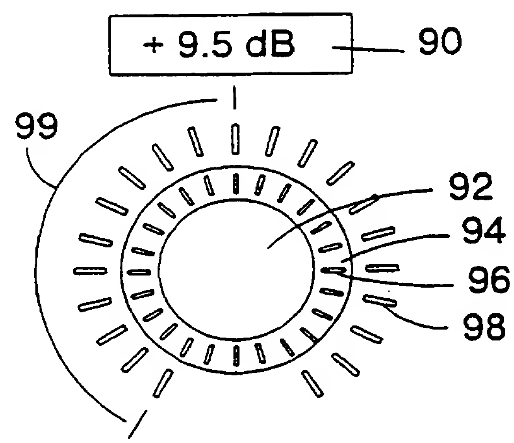
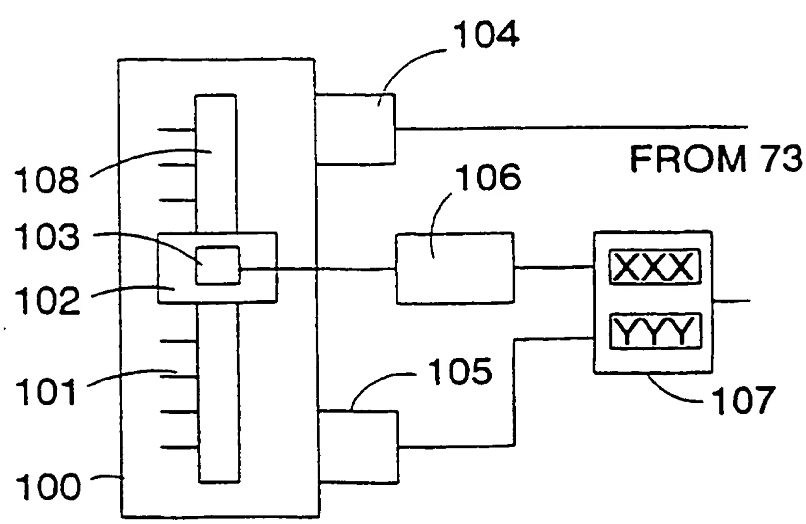


FIG. 4A

FIG. 5



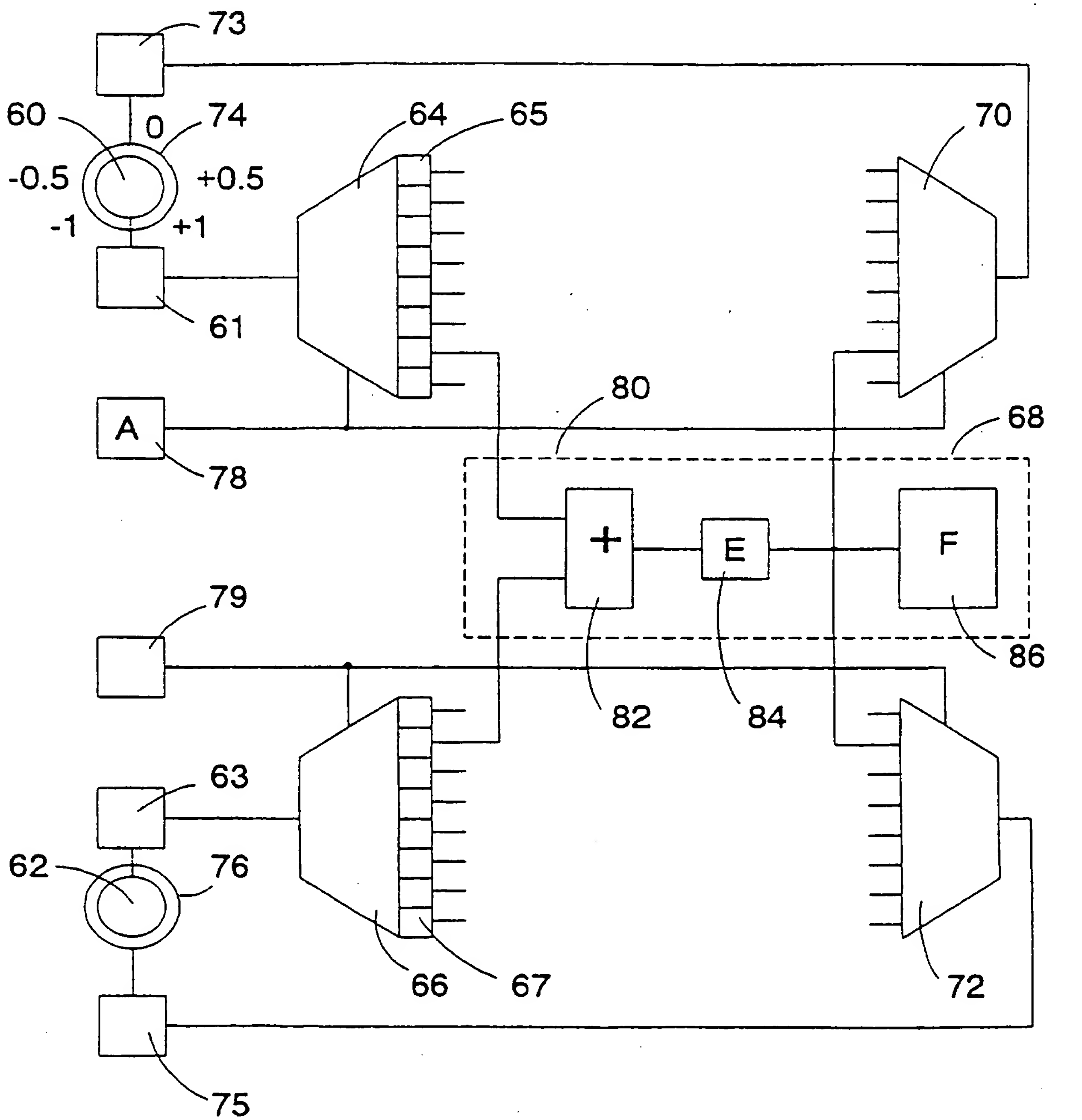

73
60
0
74
-0.5
+0.5
-1
+1
61
64
65
70
A
78
80
68
+
E
F
82
84
86
79
63
62
76
66
67
72
75

FIG. 3

2301002

AUDIO MIXING CONSOLE

This invention relates to an audio mixing console for processing a plurality of audio channels, in each of which a plurality of audio functions are to be performed.

Traditionally, audio mixing consoles have been based on discrete technology with audio signal processing modules connected together in a desired relationship and then controlled by manually operable switches on the console. However, traditional audio mixing consoles have a number of disadvantages including their physical size, the total number of manually operable controls (fader, potentiometers, switches, etc.), and the relative inflexibility of the overall arrangement.

Accordingly, it has been proposed to provide an audio mixing console comprising a front panel including a plurality of user operable controls for controlling different audio signal processing functions and a digital signal processor for processing audio signals in response to the settings of the user operable controls. It is hoped that such technology can lead to reductions in the overall size of such consoles while at the same time increasing flexibility. However, a disadvantage of such technology is the removal of the direct physical relationship between the actual audio functions and interconnections and user controls of the mixing console and the operation of those functions.

Typically, audio mixing consoles provide of the order of 128 channels, in each of which gain, equalisation and other audio processing functions can be performed. Each channel may require about 100 parameter adjustments (e.g. gain, equalisation filter frequencies, etc.,). In a traditional audio processing channel, each of these parameter adjustments will be assigned a dedicated control knob, switch or fader which results in a very large number of controls being required.

It has been proposed to reduce the number of control knobs in a multi-channel audio mixing console by assigning a reduced number of control knobs to each channel and then allowing those knobs to be used to make parameter adjustments for several different audio processing functions. In this way, a single knob may be used, for example, for gain and frequency control. It has also been proposed, for example, to use the main channel fader for filter frequency control. However, this

approach of allocating different functions to a single knob is confusing to the user and causes problems where, for example, two functions assigned to a knob need to be adjusted in different ways at the same time.

In accordance with the present invention, therefore, there is provided an audio mixing console for processing a plurality of audio channels in each of which a plurality of audio processing functions are to be performed, said audio mixing console comprising a control panel having a plurality of user operable controls, each for a respective audio processing function, said console comprising means for dynamically assigning each said user operable control to a user selectable audio processing channel.

Thus, in an embodiment of the invention, each control knob or fader or other user input control always controls a particular audio processing function, but may be used to control that function for a number of different channels. This significantly reduces the confusion experienced by an operator in that the operator will normally be directing his attention to setting up the parameters for a particular channel at any one time. Arranging the control knobs on the front panel of the mixing console in a predetermined desired arrangement means that the operator can readily locate and operate the control which is needed in order to carry out the audio processing adjustments which the operator desires to perform on the selected channel.

Accordingly, the console preferably comprises a set of user operable controls for respective audio processing functions arranged within an area on said control panel and means for dynamically assigning said set of user operable controls to a user selectable audio processing channel.

Preferably, the console additionally comprises a bank of further user operable controls in the form of faders arranged within a further area of said control panel and associated with said set of user operable controls, and means for dynamically assigning said bank of faders to a group of audio channels, said means for dynamically assigning said set of user operable controls being constrained to assign said set to one of the group of audio channels to which the faders are currently selected.

Thus, the user is readily able to assign the bank of main channel

faders to a particular group of the available channels and then to assign the set of user operable controls to one of the channels within the selected group and to perform the desired adjustments for that channel. In a preferred embodiment of the invention the faders are arranged in a row in front of the user with the user operable controls arranged on an area of the control panel immediately behind the faders.

Preferably, the console includes a plurality of sets (preferably two sets) of user operable controls, each in a respective area of said control panel and each set being individually assignable to a respective audio processing channel. Preferably, a respective bank of faders is associated with each set of user operable controls. In the preferred embodiment of the invention there are two banks of faders arranged either side of a central control area, each set of user operable controls which are assignable to a particular channel being located behind the respective bank of faders. The central control area can contain master faders and common processing functions.

Preferably, user operable control means (for example control buttons) are provided for selecting a group of channels to which a bank of faders is to be assigned and further user operable control means (e.g. control buttons) are provided for assigning the sets of user operable controls to a selected channel within the selected group of channels. In a preferred embodiment of the invention each user operable control is assigned to a particular audio processing function, although the invention does not exclude the possibility that certain user operable controls could be assigned to a plurality of functions.

Preferably the console comprises means for scanning and sampling the user operable controls to determine the actuation and current position thereof, much in the manner of the scanning of a keyboard in, for example, a computer system or the like.

Preferably, analog to digital converter means are responsive to said scanning means to convert analog sample values to corresponding digital values for processing in the console.

In order to perform the vast number of audio processing functions which are typically required in an audio mixing console, the console preferably comprises a highly parallel control and signal processing structure. Accordingly, said means for dynamically assigning said user operable controls comprises demultiplexer means for assigning a

processing channel for the processing of function values derived from a said user operable control and multiplexer means for feeding back a resulting processed function value from said processing channel, said demultiplexer and multiplexer means being responsive to a control signal indicative of the processing channel for processing said function values from said user operable control.

The user operable controls comprise means for indicating changes representative of processed function values. For example, the user operable controls can be provided with illuminated indicators indicative of a setting of the user operable control. Such an indicator is particularly applicable where the user operable control is an an endlessly rotatable knob that is a rotatable knob without end stops. The user operable controls can also be motorised whereby the motor for the control is operated automatically on receipt of processed function values from the multiplexer means.

As mentioned above, in a preferred embodiment of the invention, the audio mixing console has two sets of user operable controls contained in respective areas (sub-panels) on the control panel, which sub-panels are identical in function. Each bank of faders for the sub-panel can comprise 24 faders which may be assigned to control the gain of a group of 24 channels from 128 possible channels. The user operable controls include equalisation and effects controls which apply to a currently selected single channel from the current group of 24 channels desired processing parameters. It will be appreciated that where 2 sets of user operable controls and faders are provided, which two sets may be dynamically allocated to selected channels, a conflict could occur if a single channel were selected by both sets of user operable controls. Accordingly, it has been proposed to provide an interlock to prevent the two sub-panels being used to control the same feature of the same channel at the same time. However, this limits the freedom of operation of the panel where, for example, two operators are active at one time.

Accordingly, in a further aspect of the invention, the invention provides a console comprising a plurality of sets of user operable controls, each simultaneously assignable to the same audio processing channel and each comprising respective demultiplexer and multiplexer means, an assigned processing channel for a user operable control

comprising a folding adder function responsive to changes in the function value for said user operable control from either set of user operable controls and an end stop function responsively connected to said folding adder to prevent the function value for said processing value exceeding upper and lower limit values.

Thus, in accordance with this aspect of the invention, if the two sub-panels are set to the same group of channels or the same individual channel is selected for the set of user operable controls, any changes made on one sub-panel are mirrored by the controls on the other sub-panel. For example, if a fader is moved on one sub-panel, the corresponding fader for the corresponding channel on the other sub-panel moves under motorised control to a matching position. Also, where the control knobs are endless potentiometers for which the current "position" of the control is indicated by an illuminated segment (for example a LED) on the control knob skirt, on rotating a potentiometer on one sub-panel when the same channel is selected on the other sub-panel, the currently illuminated segment on the skirt on each of the two corresponding potentiometers is changed to reflect the new "position" of the moved potentiometer.

Preferably, each potentiometer generates function values between -1 and +1. The minus -1 and +1 positions are preferably immediately adjacent to and represent the position of the potentiometer at "6 o'clock".

The two potentiometer position outputs are supplied to the folding adder which adds the two numbers indicative of the two potentiometer positions. The term "folding adder" means that if the adder output reaches +1, further increases will cause the output to fold to -1 and continue increasing from there. This means that the adder output is always in the range -1 to +1. For example, in this folding arithmetic, the sum of +0.25 and +0.3 is +0.55, but the sum of +0.75 and +0.6 is in fact -0.65.

By supplying the output of the folding adder to an end stop, this function prevents the potentiometer output from increasing beyond +1 or decreasing further than -1. However, if the potentiometer output is end stopped at +1, any decrease in the folding adder output will cause the potentiometer output immediately to decrease from +1 towards 0. The output of the end stop function is supplied as a potentiometer

output and also controls the display surrounding each potentiometer. Thus, this arrangement means that a change in one of the potentiometers is reflected in an increase in the notional position of both potentiometers and is displayed on both potentiometer displays.

In the case of a motorised moving fader where, in effect, the display (the position of the fader bar) is also the input device, a position change output from a fader is only effected if a finger detector associated with that fader detects that the fader has been touched by the user. Thus, where the system moves the fader in response to processed function values, no new input values are generated from the fader. Only when the fader is handled by the user are new input values from the fader generated.

Preferably, said demultiplexer means comprises a data buffer for each processing channel for maintaining and updating current function values for a processing channel currently selected by said control signal and for retaining the most recent function value for a processing channel not currently selected by said control signal and for subsequently renulling a processing channel when it is reselected.

In this manner the demultiplexer means maintains the current position value for unselected functions and up-dates the position value for current selected functions. The up-dated position value is supplied to the respective end stop function. The multiplexer selects the output of the currently selected end stop function to control the display of the currently selected function value.

As mentioned above, the user operable controls include rotatable potentiometer control knobs including illuminated segments around the knob skirt. One of the segments (e.g. an LED) can be illuminated to indicate the current "position" associated with that potentiometer.

Where the skirt with its LEDs rotates with a knob, a relatively good indication of the rotation of the knob is provided. However, the provision of a rotatable skirt with a plurality of LEDs is relatively expensive. If, as an alternative, the LEDs were fixed to the panel around the knob, then a relatively poor resolution of the rotation of the potentiometer would be achieved.

Accordingly, in a further aspect of the invention, a rotary control knob is provided with a ring of illuminable segments for indicating a value currently selected by said control knob, wherein

said ring of illuminable segments is controlled to indicate a macro and a micro adjustment whereby one complete rotation of the micro adjustment corresponds to one increment of the macro adjustment, said micro and macro indicators being visually distinguishable. In this manner, a single ring of illuminable segments (e.g. LEDs) is used to indicate both a "macro" position and a "micro" position in the manner of the hour and minute hands of a clock. The micro indicator could be a single illuminated LED. In order to distinguish the two indicators, the macro indicator could be two adjacent illuminated LEDs or two diametrically opposed illuminated LEDs.

An embodiment of the invention will be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a schematic block diagram of a mixing console for audio signal processing;

Figure 2 is a schematic representation of the interconnection of user operable controls on the control panel 12 and the signal processing network of the mixing console of Figure 1;

Figure 3 is a schematic representation of the connection of two user operable controls to a single processing channel of the mixing console of Figure 1;

Figure 4 is a schematic representation of a rotary control knob with a position indicator; and

Figure 5 is a schematic representation of a fader with associated control circuitry.

Figure 1 represents a simplified schematic block diagram of a mixing console 10 for use in an audio recording studio. The console 10 comprises a front panel 12, a processor network 14 comprising an array of signal processors 15 and a plurality of control processors and buffer circuitry 16, and one or more input/output interface processors and interfaces 18. Also shown in Figure 1 is a host unit 20, which could be permanently connected to the remainder of the system, or could be connected only during initialisation and debugging stages of operation.

The panel 12 comprises an array of operator controls including faders, switches, rotary controllers, video display units, lights and other indicators, as represented in a schematic manner in Figure 1. Optionally the panel 12 can also be provided with a keyboard, tracking

device(s), etc. and general purpose processor (not shown) for the input of and control of aspects of the operation of the console. One or more of the video display units on the panel can then be used as the display for the general purpose computer.

In one embodiment, the host unit 20 is implemented as a general purpose workstation incorporating a computer aided design (CAD) package and other software packages for interfacing with the other features of the mixing console. The host unit could alternatively be implemented as a purpose built workstation including special purpose processing circuitry in order to provide the desired functionality, or as a mainframe computer, or part of a computer network. As shown in Figure 1, the control unit 20 includes a display 20D, user interface devices 20I such as a keyboard, mouse, etc., and a processing and communication unit 20P.

In normal operation, control of the mixing console is performed at the front panel, or mixing desk 12. The mixing console 10 is connected to other devices for the communication of audio and control data between the processor network 14 and various input/output devices (not shown) such as, for example, speakers, microphones, recording devices, musical instruments, etc. Operation of the studio network can be controlled at the front panel or mixing desk 12 whereby communication of data between the devices in the studio network and the implementation of the necessary processing functions is performed by the processor network 14 in response to operation of the panel controls.

The processor network 14 can be considered to be divided into a control side 16, which is responsive to the status of the various controls on the front panel 12, and an audio signal processing side 15 which implements the required audio processing functions in dependence upon the control settings and communicates audio data with the studio network via the I/O interface 18.

The processing of digital audio data is performed by a parallel signal processing array 15 comprising a large number of signal processing integrated circuits (SPICs). The SPICs operate under microprogram control, microcode being loaded by the host unit 20 in an initialisation phase of operation. In the preferred embodiment the processor network 14 is arranged on a rack to which is attached a

plurality of cards. Each card carries an array of, for example, 25 SPICs, the horizontal and vertical buses being connected between the cards so that from a logical and electrical point of view the SPICs form one large array. The buses may be connected in a loop with periodic pipeline registers to allow by-directional communication around the loop and to extend the connectivity of the array. The signal processors are also connected to the I/O interface 18.

The parallel processing array as a whole provides for the implementation of all the audio processing functions that are required depending on the configuration of the studio network and the control settings at the front panel 12 by defining digital audio processing channels on the signal processing network. The microcode loaded during the initialisation phase provides for individual audio signal processing functions, although the routing of data and the supply of coefficient data is under the control of the control processor(s) 16 at run time. To switch in or out a particular function, or to alter the routing of data, the control processor(s) 16 interface with the array of SPICs 15 to write signal data, coefficients and addresses to the SPICS and to read signal data, coefficients and addresses from the SPICS.

The control processor(s) 16 are responsive to operation of the user operable panel controls such as channel faders 26, switches 39 and control knobs 38, etc., by an operator to vary the characteristics such as signal levels, etc., of audio signals.

As can be seen in Figure 1, the control panel of the mixing console is divided into two main sub-panels 22 and 24 with a central control panel 40. The sub-panels 22 and 24 are preferably configured in the same manner so that the user may use either the left hand or right hand sub-panel without having to adapt his or her mode of operation. The central control panel 40 contains centralised functions which are applicable to the overall operation of the control panel and to the operation of the individual sub-panels 22 and 24.

Directly below each fader of the group of channel faders 26 is a control button of a bank of control buttons 32 for assigning the associated control area 30 to a particular channel to which the particular button in the button bank 32 and the corresponding fader in the fader bank 26 is assigned.

Each of the sub-panels 22 and 24 and the control panel 40 includes visual displays 34, 46 for representing desired information. Also, visual indicators are associated with the buttons 32 and 39 to indicate when they are activated and visual displays are associated with the control knobs 38 to indicate the current "position" of those control knobs.

Figure 2 is a schematic representation of the relationship between the user input devices (including the switches 32 and 36 and the analogue user devices 26 and 38) on the control panel and the processor network 14. Specifically, the control panel 12 comprises a multiplexing arrangement 52 which is responsive to a scan controller 56 to individually sample all of the user operable controls on the control panel in sequence. The values sampled from the user input devices providing binary output signals such as the switches 32 are passed directly via a line 53 to the processor network 14 as time multiplexed signals. Analogue values sampled from analogue input devices such as control knobs 38 and fader 26 are supplied in a time multiplexed manner via an A/D converter 54 to the processor network 14. Thus, the user operable controls on the control panel 12 are sampled in a manner which will be familiar to one skilled in the art of user input devices such as keyboards, etc. The scanning controller 56 can be included within the control panel 12 as illustrated in Figure 2, or, alternatively, the scan control can be provided directly from the signal processing network 14 as represented by the dashed line 58.

In operation, the user selects a particular group of 24 of the available channels (as mentioned a group of, for example, 24 channels from 128 channels in the preferred embodiment), by operation of an appropriate one of the block of keys 28 for a particular sub-panel (e.g. sub-panel 22). Then, by operation of the control key 32 above a particular channel fader in the bank of faders 26, the user assigns the control knobs and buttons 38 and 39 of the control area 30 to the selected channel. The control parameters for that audio processing channel can then be adjusted and controlled by operation of the user operable control knobs 38, buttons 39, and the channel fader for that channel. At the same time, the gain for the other channels in the selected group of channels can be adjusted by the other faders within the bank of faders 26. The group of channels selected can be changed

at any time by operation of an appropriate key in the block of keys 28 and the assignment of the control knobs 38 and buttons 39 in the control area 30 can be changed to any one of channels of the selected group of channels by operation of the appropriate control button in the bank of control buttons 32.

As it is necessary to maintain the values set in each of the variable channels, whether or not they are currently selected for adjustment on the sub-panel 22, it is necessary that the control values associated with each of the user operable controls is separately controlled in a signal processing channel for the corresponding audio processing channel.

Also, given that two sub-panels 22 and 24 are provided on the control panel 12 and in order that each sub-panel can be freely assigned to any desired group of channels and the control area 30 for each of the sub-panels 22 and 24 can be freely assigned to an individual channel, it is necessary to provide a control structure which enables contention to be resolved when a user operable control is assigned to the same function within the same channel on each of the sub-panels 22 and 24.

Figure 3 is a schematic representation of the control structure in accordance with the present invention which enables these objects to be met.

In Figure 3, 60 and 62 represent two endlessly rotatable control knobs on the first sub-panel 22 and the second sub-panel 24, respectively. The console is responsive to a change in position of the control knob 60 as sampled by the scanning mechanism to generate an output representative of an incremental rotation of the control knobs 60 and 62. The function of generating the incremental rotation signal is represented at 61 for the control knob 60 and at 63 for the control knob 62. This function can be provided in the signal processing structure or could be provided in the control panel itself. Typically an absolute position value for each user operable control on each scan of the user operable controls is stored and then a difference signal is generated by comparison of the currently sampled value with a previously stored value.

It will be appreciated that the direct line connection between the control knobs 60/62 and the respective position signal generation

61/63 represent, in this case, a connection via the control structure illustrated in Figure 2. The output from the position signal generator 61/63 is supplied to a demultiplexer/assignment function 64/66 which dynamically assigns the control knob to one of the available signal processing channels (in the present embodiment 128 signal processing channels).

The multiplexer/assignment function 64 for the control knob 60 is controlled by a channel selection controller 78 which is responsive to the operation of one of the block of control buttons 28 to select a group of control channels and the operation of an individual control button in the bank of control buttons 32 to select an individual channel. The output of the position signal generator 61 for the control knob 60 is arranged to generate a signal in fractional 2's complement arithmetic having a value between -1 and +1. The position of the control knob is thus encoded as a binary value between -1 and +1. The -1 and +1 values are representative of positions immediately adjacent to "6 o'clock". The output of the position signal generator 61 is supplied via the multiplexer/assignment function 64 to the appropriate signal processing channel 68 in accordance with the channel selection from the channel selection controller.

Similarly, the position signal generator 63 generates a position output indicative of the position of the control knob in fractional 2's complement notation with the position of the control knob encoded as a binary value between -1 and +1, the -1 and +1 positions being immediately adjacent to and representative of the position of the control knob at "6 o'clock".

The output of the position indicator 63 is supplied via the multiplexer/assignment function 66 to the audio processing channel 68 as determined by the channel selection controller 79. The channel selection controller 79 is responsive to the operation of one of the block of control buttons 28 to select a group of channel and operation of a selected one of a bank of control buttons 32 to select a particular channel.

In the present instance, it is assumed that both the control knob 60 and the control knob 62 are assigned to the same audio processing channel 68 and represent the same function within the channel. The outputs of the multiplexer/assignment function 64 and 66 are supplied

to a folding adder 82 which adds the two numbers indicative of the two control knob positions. The term "folding adder" means that when the adder output reaches +1, further increases will cause the output to fold to -1 and continue increasing from there. This means that the adder output is always in the range of -1 to +1. For example, in this folding arithmetic, the sum of +0.25 and +0.3 is +0.55, but the sum of +0.75 and +0.6 is in fact -0.65. The output of the folding adder 82 is supplied to an end stop controller 84. This controller does not allow an output value to increase beyond +1 or decrease further than -1. However, if the output is end stopped at +1, any subsequent decrease in the folding adder output will cause the pot output immediately to decrease from +1 towards 0. It will be noted that the operation of the multiplexer 70 and 72 is controlled by the output of the channel selection controllers 78 and 79, respectively. The output of the end stop controller 84 is also supplied to control the audio signal processing function 86 within the signal processing channel 68.

The output of the multiplexer 70 is supplied to a display controller 73 for controlling a display 74 representative of the current position of the endlessly rotatable control knob 60. The values -1, -0.5, 0, +0.5 and +1 shown in Figure 3 are not actually displayed on the display 74, rather they represent the position around the circumference of the control knob corresponding to the various values of the output of the multiplexer 70 and the values supplied by the position indicator 61.

Similarly, the output of the multiplexer 72 is supplied to a display controller 75 for controlling the current display position of the control knob 76.

As a result of this control structure, any change in one of the control knobs 60 or 62 will cause a resulting change in the indicated position of that control knob and also of the indicated position of the other of said control knobs.

As it is possible at any time during operation of the device to change the channel to which the user operable controls (for example the control knob 60) is assigned, it is necessary to retain the last user operable control position selected for a particular channel when that channel is no longer selected so that, on re-selecting the channel, the current value can be recovered. Accordingly, for this purpose, each

multiplexer/assignment function 64 is provided with a bank of signal buffers 65 in which the last selected value for each of the available channels is retained.

Figure 4 is a schematic representation of a continuously rotatable control knob 60 with an absolute position detector 87 for detecting the absolute position of the control knob and a display controller 73 for controlling the display of the current position of the control knob by means of a position indicator 74 comprising a plurality of illuminable segments 88. In the preferred embodiment of the invention, the position indicator 74 comprises a ring of 30 - 40 LEDs which are arranged as a skirt around a control knob, but are fixed to the control panel surrounding said control knob. The illumination of the individual LEDs is arranged to be performed in the manner of the hour and minute hands on a clock so that "macro" and "micro" position changes can be represented. For example, one complete rotation of the micro position indicator could represent one increment of the macro position indicator.

In one embodiment of the invention, the micro position indicator is represented by a single illuminated LED. A macro position indicator, on the other hand, is identified by two illuminated LEDs, which can either be immediately adjacent one another, or diametrically opposed to one another.

Figure 4a illustrates an alternative display arrangement for a rotatable knob. In this display arrangement, a rough knob value can be indicated by a first ring of LED indicators 96 provided on a skirt 94 which rotates with a knob 92 and a second ring of position indicators 98 fixed to the front of the control panel. The range indicated by the curve 99 can be changed according to use. The rotation indicated by the curve 99 could, for example, be 20dB or 3dB. In addition, an accurate knob value could be indicated by means of a digital display 90.

As an alternative, the position indicator 74 could comprise two concentric rings of LEDs with the micro position indicator being represented by illumination of a corresponding position LED in both the inner and outer ring and the macro position indicator being represented by the illumination of a single LED on the inner ring of LEDs. It will be appreciated that other specific configurations of LEDs could be

employed to represent the micro and macro position indicators. For example, differently coloured LEDs could be used to represent the macro and micro functions.

Figure 5 is schematic representation of a user operable control in the form of a fader. The fader 100 comprises a scale 101 with a fader bar 102 which is slidable between end positions along a slide 108. The current position of the fader bar 102 is represented by a position sensor 105. The fader of Figure 5 is motorised by means of a motor 104 which is responsive to signals received, for example, from a display controller such as the display controller 73 of Figure 3. It will be appreciated that a manual fader of the type illustrated in Figure 5 does not require a separate position indicator to indicate the current position of that fader, this being represented instead by movement of the fader bar 102 by the motor 104 in response to signals from the display controller 73. However, this arrangement can provide problems in a situation such as illustrated, for example, in Figure 3 where it is necessary to distinguish between operation of the fader by the system and operation of the fader by the user.

Accordingly, in order to detect whether a user is operating the fader control, a sensor 103 is provided on the fader bar. A detector 106 detects operation of the sensor 103. Preferably, the sensor 103 is a capacitive sensor for detecting the presence of an operator's finger. By the provision of the capacitive sensor 103 and the detector 106, it is possible to determine when movement of the fader has been performed by the user. Only in this case is the output of the position detector 105 used to indicate a changed input variable for processing. This is achieved by a nulling function 107, controlled by the output of the touch detector 106. When the touch detector output is 'off', indicating that the user is not touching the fader, the motor 104 can position the fader in response to the display controller 73. During this operation, the nulling function 107 stores the current position of the fader from the position detector 105 in a register XXX (not shown). When the user touches the fader, the touch detector 106 operates to freeze the current value in the register XXX. If the fader is now moved by the user, the difference between the stored value in the register XXX and the instantaneous value from the position detector 105 is output via a register YYY (not shown) for subsequent processing.

When the fader is released by the user, and the fader is subsequently moved by the motor 104, the output value in the register YYY is held constant while the value in the register XXX is updated with the current value from the position detector. On subsequent operation of the touch detector 106 the difference between the current value of the position detector 105 and the register XXX is added to the register YYY to provide the new output value. In this way the output value always represents the total sum of all position movements while the touch sensor was active, irrespective of any motor-driven movements which may have occurred in between.

There has been described various aspects of an audio mixing console with user controls which can be dynamically allocated to respective processing channels. As a result of the present invention, it is possible to provide a compact audio mixing console with full functionality, but with only a relatively small number of user operable controls including allocatable channel faders and allocatable audio signal processing control knobs and buttons, etc. There has been described a data processing structure whereby individual control values for the user operable controls can be updated, maintained and retained for each of the processing channels which can be allocated to the individual user operable controls. Also, a processing structure has been described whereby a single processing channel can be allocated to a user operable control on two sub-panels of the control panel and the user operable controls on both sub-panels can be used separately to control the processing within that channel. There has also been described aspects of the display of the resulting changes in the user operable control "positions" as a result of the dual control of a processing function within a processing channel by respective user operable controls on the respective sub-panels.

Although particular embodiments of the invention have been described in the present application, it will be appreciated that many modifications and/or additions may be made to the particular embodiments within the scope of the present invention.

For example, although in Figure 1 a control panel is shown which comprises two sub-panels and a central control area, it will be appreciated that a different number of sub-panels could be provided in an alternative embodiment of the invention. Also, a different number

of faders could be provided within each sub-panel. Moreover, it will be appreciated that a different arrangement of the various control areas within the control panel could be provided in alternative embodiments of the invention.

The Patent Office

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Application No:	GB 9510201.8	**Examiner:**	Keith Williams
Claims searched:	1-23	**Date of search:**	20 July 1995

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.N): H4R (RSX)

Int Cl (Ed.6): H04H 7/00

Other: online WPI, INSPEC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0576110 A2	Wandel and Goltermann - see abstract	
X	EP 0251646 A2	Amek Systems - see page 5, lines 47-52, & US 4879751	1 at least
X	US 5233666	Sony Corp. - see abstract	1 at least
A	US 5060272	Yamaha Corp. - see abstract	
X	WPI Abstract Accession No. 94-110536/14 & DE 4236156 C1 (Wandel) 21.04.94 (see abstract)		1 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.